Supplementary Table S1. Representative summary of successful studies using *in planta* and topical RNAi to control insect pests in plants. HIGS: host-induced gene silencing (transgenesis), SIGS: spray-induced gene silencing (injection, transient, ingestion, or spray), and VIGS: virus-induced gene silencing (viral vectors).

Strategy	RNAi	Insect pest	Target gene	Organism	Results	References
HIGS	dsRNA with viroid-like structure	*Anthonomus grandis*	*Chs2*, *Vg*, and *ETHr*	Cotton	Reduced plant susceptibility	[1]
HIGS	Intron-containing hairpin RNA	*Diabrotica virgifera virgifera*	*DvSnf7*	Maize	Reduced plant susceptibility	[2-4]
SIGS	dsRNA	*Anthonomus grandis*	*JHDK*, *JHEH*, and *MFE*	Insect	Increased insect susceptibility	[5]
SIGS and HIGS	dsRNA and intron-containing hairpin RNA	*Diabrotica virgifera virgifera*	Multiple target genes *V-ATPase 7*	Maize	Reduced plant susceptibility	[6]
HIGS	Intron-containing hairpin RNA	*Nilaparvata lugens*	*NlHT1*, *Nlcar*, and *Nltry*	Rice	Reduced plant susceptibility	[7]
SIGS and VIGS	dsRNA and antisense expression	*Helicoverpa armigera*	*AChE*, *EcR*, and *v-ATPase-A*	Potato	Increased insect susceptibility	[8]
SIGS and VIGS	dsRNA and intron-containing hairpin RNA	*Frankliniella occidentalis*	*ACT*, *TUB*, *VAT*, and *SNF*	Tobacco	Increased insect susceptibility	[9]
SIGS and VIGS	dsRNA delivery from *E. coli* extract and intron-containing hairpin RNA	*Helicoverpa armigera*	Multiple target genes *HaHR3*	Tobacco	Increased insect susceptibility	[10]
SIGS and VIGS	dsRNA and spacer-containing hairpin RNA	*Diabrotica virgifera virgifera* *Meligethes aeneus*	Multiple target genes *Rop*, *dre4*, and *RpII140*	Maize	Increased insect susceptibility	[11]
SIGS	dsRNA	*Anthonomus grandis*	*AgraNuc1*, *AgraNuc2*, and *AgraNuc3*	Insect	Increased insect susceptibility	[12]
SIGS	dsRNA	*Anthonomus grandis*	*Laccase2* and *AgraCHS2*	Insect	Increased insect susceptibility	[13, 14]
SIGS	dsRNA	*Rhynchophorus ferrugineus*	*α-amylase*, *V-ATPase*, and *Ecdysone receptor*	Insect	Increased insect susceptibility	[15]
HIGS	Intron-containing hairpin RNA	*Bemisia tabaci*	*v-ATPase*, *AQP*, and *AGLU*	Lettuce, tobacco, and tomato	Reduced plant susceptibility	[16-19]
SIGS	dsRNA	*Diaphorina citri* *Bemisia tabaci* *Homalodisca vitripennis*	*Trehalase*, *Cactin*, and *Syntaxin 1A*	Insect	Increased insect susceptibility	[20]
SIGS and VIGS	dsRNA	*Bemisia tabaci*	Horizontally transferred gene	Insect	Increased insect susceptibility	[21]

SIGS and VIGS	dsRNA and intron-containing hairpin RNA	*Bemisia tabaci*	*AQP1*, *SUC1*, *dsRNase1*, *jhe*, and *dsRNase2*	Insect	Increased insect susceptibility	[22, 23]
SIGS	dsRNA	*Euscelidius variegatus*	*ATP synthase β*	Insect	Reduced phytoplasma multiplication	[24]
HIGS	Intron-containing hairpin RNA	*Helicoverpa armigera*	*JHAMT* and *JHBP*	Cotton	Reduced plant susceptibility	[25]
HIGS	Inverted repeat transgene	*Bemisia tabaci*	*BtGSTs5*	Arabidopsis	Reduced plant susceptibility	[26]
SIGS	dsRNA	*Bemisia tabaci*	*Bt56* Multiple target genes	Tobacco and insect	Increased insect susceptibility	[27, 28]
HIGS	Intron-containing hairpin RNA	*Leptinotarsa decemlineata*	*EcR*	Potato	Reduced plant susceptibility	[29]
HIGS	Intron-containing hairpin RNA	*Myzus persicae*	*MyCP*	Arabidopsis	Reduced plant susceptibility	[30]
SIGS	dsRNA	*Riptortus pedestris*	*rip-thanatin*	Insect	Increased bacterial infection	[31]
SIGS	dsRNA	*Scirpophaga incertulas*	*AChE*	Insect	Increased insect susceptibility	[32]
HIGS	Intron-containing hairpin RNA	*Sitobion avenae*	*SaZFP* and *CHS1*	Wheat and barley	Reduced plant susceptibility	[33, 34]
HIGS	miRNA expression	*Chilo suppressalis*	*Csu-miR-14* and *csu-novel-miR15*	Rice	Reduced plant susceptibility	[35, 36]
HIGS	amiRNA expression	*Helicoverpa armigera*	*ACE2*, *Chs*, and *HaAce1*	*Nicotiana benthamiana* and tobacco	Reduced plant susceptibility	[37-39]
HIGS	amiRNA expression	*Myzus persicae*	*MpAChE2*	Tobacco	Reduced plant susceptibility	[40]
SIGS	dsRNA	*Diaphorina citri*	*dsAK*, *EstFE4*, *AChe*, and *CYP4*	Citrus	Increased insect susceptibility	[41-43]
SIGS	dsRNA	*Diaphorina citri*	*DcTPS*, *DcGSTe2*, *DcGSTd1*, and *Awd*	Insect	Increased insect susceptibility	[44-46]
SIGS	dsRNA	*Tribolium castaneum*	Multiple target genes	Insect	Increased insect susceptibility	[47]
SIGS	dsRNA	*Tuta absoluta*	*JHBP* and *v-ATPase*	Tomato	Increased insect susceptibility	[48]
SIGS	dsRNA	*Tetranychus urticae*	*TuVATPase*	Insect	Increased insect susceptibility	[49]
SIGS and HIGS	dsRNA and inverted repeat transgene	*Tuta absoluta*	*vATPase-A* and *AgK* Multiple target genes	Tomato	Increased insect susceptibility	[50, 51]

SIGS	dsRNA	*Sitobion avenae*	*SaLac1*	Wheat	Increased insect susceptibility	[52]
HIGS	Sense and antisense expression	*Sitobion avenae*	*shp*	Barley	Reduced plant susceptibility	[53]
SIGS	dsRNA	*Toxoptera citricida*	*KAT*, *PEPCK*, and *GP*	Citrus	Increased insect susceptibility	[54]
HIGS	Inverted repeat transgene	*Myzus persicae*	*Spr2:HPL*	Tomato	Reduced plant susceptibility	[55]
SIGS and VIGS	dsRNA and inverted repeat transgene	*Myzus persicae*	*MpC002*, *MpPIntO2*, and *Rack-1*	*Nicotiana benthamiana* and Arabidopsis	Increased insect susceptibility	[56, 57]
SIGS	dsRNA	*Acyrthosiphon pisum*	*Ap-crt* and *Ap-cath-L*	Insect	Increased insect susceptibility	[58]
SIGS	dsRNA	*Tribolium castaneum*	*TcCTLP-5C*, *TcLgl*, and *TcCTLP-6E*	Insect	Increased insect susceptibility	[59, 60]
SIGS	dsRNA	*Spodoptera exigua*	*SeChi*, *SeChi-h*, *CPG316*, *CPG860*, and *CPG4855*	Insect	Increased insect susceptibility	[61, 62]
SIGS and VIGS	dsRNA and intron-containing hairpin RNA	*Diabrotica virgifera virgifera*	*Dvvgr* and *Dvbol*	Maize	Reduced plant susceptibility	[63]
SIGS	dsRNA	*Tribolium castaneum* *Acyrthosiphon pisum*	*VTE* and *IAP*	Insect	Increased insect susceptibility	[64]
SIGS	dsRNA	*Aphis glycines*	*TREH*, *ATPD*, *ATPE*, and *CHS1*	Insect	Increased insect susceptibility	[65]
SIGS	dsRNA	*Ostrinia furnacalis*	*CHT10*	Insect	Increased insect susceptibility	[66]
SIGS	dsRNA	*Leptinotarsa decemlineata*	Multiple *RNases*	Insect	Increased insect susceptibility	[67]
SIGS	dsRNA	*Dendroctonus ponderosae* *Dendroctonus frontalis*	*HSP*, *IAP*, and *SHI*	Insect	Increased insect susceptibility	[68, 69]
SIGS	dsRNA	*Anoplophora glabripennis*	*IAP*, *SSK*, and *SNF7*	Insect	Increased insect susceptibility	[70, 71]
SIGS	dsRNA	*Agrilus planipennis*	*IAP*, *COP*, *HSP*, and *SHI*	Insect	Increased insect susceptibility	[72, 73]
SIGS	dsRNA	*Lymantria dispar*	*LdOA1* and *LdisOrCo*	Insect	Increased insect susceptibility	[74, 75]

SIGS	dsRNA	*Choristoneura fumiferana*	*CfCDA*	Insect	Increased insect susceptibility	[76]
SIGS	dsRNA delivery from *E. coli* extract	*Plagiodera versicolora*	*SRP54*, *ACT*, *HSC70*, *SHI*, *CACT*, and *SNAP*	Insect	Increased insect susceptibility	[77]
SIGS	dsRNA	*Dendroctonus armandi*	*DarmCSP2* and *DaAqps*	Insect	Increased insect susceptibility	[78, 79]
SIGS	dsRNA produced and delivered by *Bacillus thuringiensis*	*Plutella xylostella* *Spodoptera littoralis*	*PxAK* and *Sl102*	Insect	Increased insect susceptibility	[80, 81]

Supplementary Table S2. Representative summary of successful studies using *in planta* and topical RNAi to control plant-parasitic nematodes in plants. HIGS: host-induced gene silencing (stable or composite transgenic plants), SIGS: spray-induced gene silencing (soaking), and VIGS: virus-induced gene silencing (viral vectors).

Strategy	RNAi	Nematode	Target gene	Organism	Results	References
HIGS	Inverted repeat transgene	*Meloidogyne incognita*, *M. javanica*, *M. arenaria*, *M. chitwoodi*, and *M. hapla*	*16D10*	Arabidopsis, potato, and grapevine	Reduced plant susceptibility	[82-84]
HIGS	Inverted repeat transgene	*Heterodera schachtii*	*Hs30D08*	Arabidopsis	Reduced plant susceptibility	[85]
HIGS	Inverted repeat transgene	*Meloidogyne hapla*, *M. arenaria*, and *M. graminicola*	*Mi-msp2*	Arabidopsis	Reduced plant susceptibility	[86]
SIGS and HIGS	dsRNA and inverted repeat transgene	*Meloidogyne incognita*	Multiple genes	Arabidopsis	Reduced plant susceptibility	[87]
VIGS	Antisense expression	*Meloidogyne incognita*	*SmD1* of plant	Arabidopsis, *Nicotiana benthamiana*, and tomato	Reduced plant susceptibility	[88]
HIGS	Intron-containing hairpin RNA	*Meloidogyne incognita*	*Mimsp-18* and *Mimsp-20*	Eggplant	Reduced plant susceptibility	[89]
SIGS and HIGS	dsRNA and inverted repeat transgene	*Meloidogyne incognita*	*Mi-sbp-1*	Tobacco	Reduced plant susceptibility	[90]
HIGS	Intron-containing hairpin RNA	*Meloidogyne incognita*	*Mi-msp-1*	Eggplant	Reduced plant susceptibility	[91]
HIGS	amiRNA	*Heterodera glycines*	*HgJ15*, *HgJ20*, and *HgJ23*	Soybean	Reduced plant susceptibility	[92]
HIGS	Inverted repeat transgene	*Heterodera glycines*	*HgY25* and *HgPrp17*	Soybean	Reduced plant susceptibility	[93]
SIGS and HIGS	dsRNA and intron-containing hairpin RNA	*Heterodera avenae*	*Gal*, *cath L*, *vap1*, *serpin*, *flp12*, and *RanBPM chs*	Wheat	Reduced plant susceptibility	[94]
HIGS	Inverted repeat transgene	*Meloidogyne graminicola*	*Mgflp-1* and *Mgflp-12*	Rice	Reduced plant susceptibility	[95]
HIGS	Inverted repeat transgene	*Meloidogyne incognita*	*MiCS*, *MiGPI*, and *MiTH1*	Tobacco	Reduced plant susceptibility	[96]

HIGS	Intron-containing hairpin RNA	*Meloidogyne incognita*	*MiPDI1*	Arabidopsis	Reduced plant susceptibility	[97]
HIGS	Intron-containing hairpin RNA	*Meloidogyne incognita*	*Minc16803*	Arabidopsis	Reduced plant susceptibility	[98]
HIGS	Intron-containing hairpin RNA	*Meloidogyne incognita*	*Minc01696*, *Minc00344*, and *Minc00801*	Soybean and tobacco	Reduced plant susceptibility	[99]
HIGS	Intron-containing hairpin RNA	*Meloidogyne incognita*	*Minc03328*	Arabidopsis	Reduced plant susceptibility	[100]
HIGS	Intron-containing hairpin RNA	*Meloidogyne incognita*	*Mi-cpl*, *Mi-icl*, and *Mi-sf*	Cotton	Reduced plant susceptibility	[101]
HIGS	Intron-containing hairpin RNA	*Meloidogyne incognita*	*MiDaf16-like1* and *MiSkn1-like1*	Arabidopsis and tobacco	Reduced plant susceptibility	[102]
HIGS	Intron-containing hairpin RNA	*Meloidogyne incognita*	*Splicing factor* and *integrase*	Arabidopsis	Reduced plant susceptibility	[103]
HIGS	Intron-containing hairpin RNA	*Heterodera schachtii*	*3B05*, *4G06*, *8H07*, and *10A06*	Arabidopsis	Reduced plant susceptibility	[104]
SIGS	dsRNA	*Heterodera glycines*	Multiple genes of nematode	Nematode	Nematode suppression	[105]
SIGS	dsRNA	*Globodera rostochiensis*	*gr-ams-1* and *ß-1,4,endoglucanases*	Nematode	Nematode suppression	[106]
SIGS	dsRNA	*Meloidogyne incognita*	*Mi-crt* and *Mi-pg-1*	Nematode	Nematode suppression	[107]
SIGS and HIGS	dsRNA and inverted repeat transgene	*Meloidogyne incognita*	Multiple genes of nematode	Tobacco	Reduced plant susceptibility	[108]
HIGS	Inverted repeat transgene	*Heterodera glycines*	*MSP* genes of nematode	Soybean	Reduced plant susceptibility	[109]
HIGS	Intron or spacer-containing hairpin RNA	*Meloidogyne javanica*	*MjTis11*	Tobacco	Reduced plant susceptibility	[110]
HIGS	Inverted repeat transgene	*Heterodera glycines*	*Hg-rps-3a*, *Hg-rps-4*, and *Hg-spk-1*	Soybean	Reduced plant susceptibility	[111]
HIGS	Intron-containing hairpin RNA	*Heterodera glycines*	*Fib-1* and *Y25C1A.5*	Soybean	Reduced plant susceptibility	[112]

HIGS	Inverted repeat transgene	*Heterodera glycines*	*Cpn-1*, *Y25*, and *Prp-17*	Soybean	Reduced plant susceptibility	[113]
SIGS and HIGS	dsRNA and inverted repeat transgene	*Meloidogyne incognita*	*Mispc3* and *Miduox*	Arabidopsis	Reduced plant susceptibility	[114]
HIGS	Inverted repeat transgene	*Meloidogyne incognita*	*LDH, ATP, TP*, and *MSP*	Soybean	Reduced plant susceptibility	[115]
SIGS and HIGS	dsRNA and intron-containing hairpin RNA	*Meloidogyne incognita*	*Mi-Rpn7*	Soybean	Reduced plant susceptibility	[116]
HIGS	Intron-containing hairpin RNA	*Meloidogyne incognita*	*Mi8D05*	Arabidopsis	Reduced plant susceptibility	[117]
SIGS and HIGS	dsRNA and inverted repeat transgene	*Meloidogyne incognita*	*Mi-CRT*	Arabidopsis	Reduced plant susceptibility	[118, 119]
HIGS	Inverted repeat transgene	*Meloidogyne javanica*	*Mj-FAR-1*	Tomato	Reduced plant susceptibility	[120]
HIGS	Intron-containing hairpin RNA	*Meloidogyne javanica* and *M. incognita*	*flp-1*, *flp-12*, *flp-14*, and *flp-18*	Tobacco and tuberosa	Reduced plant susceptibility	[121, 122]
HIGS	Inverted repeat transgene	*Globodera pallida*	*Gp-hyp*	Potato	Reduced plant susceptibility	[123]
HIGS	Intron-containing hairpin RNA	*Meloidogyne incognita*	*GmPG* of plant	Soybean	Reduced plant susceptibility	[124]
HIGS	Intron-containing hairpin RNA	*Heterodera glycines*	*SCN-Chs*	Soybean	Reduced plant susceptibility	[125]
SIGS and HIGS	dsRNA and inverted repeat transgene	*Meloidogyne incognita*	*Midcr-1.1*	Arabidopsis	Reduced plant susceptibility	[126]
SIGS	dsRNA	*Pratylenchus thornei* and *P. zeae*	*pat-10* and *unc-87*	Nematode	Nematode suppression	[127]
SIGS and HIGS	dsRNA and intron-containing hairpin RNA	*Radopholus similis*	Multiple genes of nematode	Banana	Reduced plant susceptibility	[128]
HIGS	Intron-containing hairpin RNA	*Meloidogyne incognita*	*Mi-asp-1*, *Mi-ser-1*, and *Mi-cpl-1*	Tobacco	Reduced plant susceptibility	[129]
HIGS	Intron-containing hairpin RNA	*Meloidogyne incognita*	*HSP70* and *ICL*	Tobacco	Reduced plant susceptibility	[130]

SIGS	dsRNA	*Meloidogyne incognita*	*Mi-flp-18* and *Mi-mpk-1*	Nematode	Nematode suppression	[131]
HIGS	Spacer-containing hairpin RNA	*Meloidogyne incognita*	*PolA1*	Tobacco	Reduced plant susceptibility	[132]
HIGS	Intron-containing hairpin RNA	*Meloidogyne incognita*	*MiMsp40*	Arabidopsis	Reduced plant susceptibility	[133]
VIGS	Antisense expression	*Meloidogyne enterolobii*	*MeTCTP*	Tomato	Reduced plant susceptibility	[134]
HIGS	Intron-containing hairpin RNA	*Ditylenchus destructor*	*unc-15*	Sweet potato	Reduced plant susceptibility	[135]
SIGS and HIGS	dsRNA and intron-containing hairpin RNA	*Radopholus similis*	*Rs-CB-1*	Tobacco	Reduced plant susceptibility	[136]
HIGS	Inverted repeat transgene	*Pratylenchus vulnus*	*Pv010*	Walnut	Reduced plant susceptibility	[137]
HIGS	Intron-containing hairpin RNA	*Radopholus similis*	*Rs-cps*	*Nicotiana benthamiana*	Reduced plant susceptibility	[138]
SIGS	dsRNA	*Bursaphelenchus xylophilus*	*Bx-myo-3*, *Bx-tmy-1*, *Bx-hsp-1*, and *Bx-cyc-2.1*	Nematode	Nematode suppression	[139]

Supplementary Table S3. Representative **s**ummary of successful studies using *in planta* and topical RNAi to control viruses and subviral agents in plants. HIGS: host-induced gene silencing (transgenesis), SIGS: spray-induced gene silencing (topical or transient dsRNA expression).

Strategy	RNAi	Viruses	Target gene	Organism	Results	Reference
HIGS	Intron-containing hairpin RNA	*Wheat streak mosaic virus*	*NIa*	Wheat	Immunity to WSMV	[140]
HIGS	amiRNA395	*Wheat streak mosaic virus*	Multiple target regions	Wheat	Reduced plant susceptibility	[141]
HIGS	Sense and antisense expression	*Rice tungro bacilliform virus*	ORF IV	Rice	Reduced plant susceptibility	[142]
HIGS	Spacer-containing hairpin RNA	*Rice dwarf virus*	*Pns12* and *Pns4*	Rice	Reduced plant susceptibility	[143]
HIGS	Inverted repeat transgene	*Rice stripe virus*	*CP*, *SP*, and *CP/SP*	Rice	Reduced plant susceptibility	[144]
HIGS	Spacer-containing hairpin RNA	*Rice stripe virus*	Multiple target regions	Rice	Reduced plant susceptibility	[145]
HIGS	Intron-containing hairpin RNA	*Potato virus X* *Potato virus Y* *Potato leaf roll virus*	*ORF2*, *HC-Pro*, and *CP*	Potato	Reduced plant susceptibility	[146]
HIGS	Intron-containing hairpin RNA	*Potato virus X* *Potato virus Y* *Potato virus S*	*CP*	Potato	Reduced plant susceptibility	[147]
SIGS	Intron-containing hairpin RNA	*African cassava mosaic virus*	Multiple target regions	*Nicotiana benthamiana*	Reduced plant susceptibility	[148]
HIGS	Intron-containing hairpin RNA	*Soybean mosaic virus* *Bean yellow mosaic virus*	*CP*	Tobacco	Reduced plant susceptibility	[149]
HIGS	Intron-containing hairpin RNA	*Bean golden mosaic virus*	*AC1*	Common bean	Reduced plant susceptibility	[150, 151]
HIGS	amiRNA	*Ugandan cassava brown streak virus* *Cassava brown streak virus*	Multiple target regions	Tobacco	Reduced plant susceptibility	[152]
HIGS	Intron-containing hairpin RNA	*Ugandan cassava brown streak virus* *Cassava brown streak virus*	*CP*	Cassava	Reduced plant susceptibility	[153-155]
HIGS	Inverted repeat transgene	*Pepper mottle virus*	*HC-Pro* and *NIb*	*Nicotiana benthamiana*	Reduced plant susceptibility	[156]

HIGS	Intron-containing hairpin RNA	*Cowpea severe mosaic virus* *Cowpea aphid-borne mosaic virus*	*Proteinase cofactor* and *CP*	Cowpea	Reduced plant susceptibility	[157]
HIGS	Intron-containing hairpin RNA	*Soybean mosaic virus*	*HC-Pro*	Soybean	Reduced plant susceptibility	[158]
SIGS	dsRNA delivery from *E. coli* extract	*Sugarcane mosaic virus*	*CP*	Sugarcane	Reduced plant susceptibility	[159]
SIGS	Encapsulated dsRNA	*Pepper mild mottle virus* *Cucumber mosaic virus*	*Rep* and *2b*	Tobacco and Cowpea	Reduced plant susceptibility	[160]
SIGS	Encapsulated dsRNA	*Bean common mosaic virus*	*Nib* and *CP*	Tobacco and Cowpea	Reduced plant susceptibility	[161]
SIGS	dsRNA	*Cucumber mosaic virus*	*2b* and *CP*	Tobacco and quinoa	Reduced plant susceptibility	[162]
HIGS	Spacer-containing hairpin RNA	*Cucumber mosaic virus*	*CP*	Tobacco	Reduced plant susceptibility	[163]
HIGS	Intron-containing hairpin RNA	*Cucumber mosaic virus*	*RNA2* and *CP*	*Nicotiana benthamiana*	Reduced plant susceptibility	[164]
SIGS	dsRNA	*Zucchini yellow mosaic virus*	*HC-Pro* and *CP*	Cucumber, watermelon, and squash	Reduced plant susceptibility	[165]
SIGS	dsRNA	*Tomato leaf curl virus* *Cucumber mosaic virus*	Multiple target regions	Tomato and tobacco	Reduced plant susceptibility	[166]
SIGS	dsRNA	*Tomato spotted wilt virus*	*N* and *NSm*	*Nicotiana benthamiana* and tomato	Reduced plant susceptibility	[167]
SIGS	dsRNA	*Tomato yellow leaf curl virus*	*C4* and *V2*	Tomato	Reduced plant susceptibility	[168]
SIGS	dsRNA	*Groundnut bud necrosis virus*	*NSs*	*Nicotiana benthamiana* and cowpea	Reduced plant susceptibility	[169]
SIGS	dsRNA delivery from *E. coli* extract	*Cucumber mosaic virus*	*2b*	Pepper	Reduced plant susceptibility	[170]
SIGS	dsRNA	*Tobacco mosaic virus*	*p126* and *CP*	Tobacco	Reduced plant susceptibility	[171]
SIGS	dsRNA	*Pigeonpea sterility mosaic emaravirus*	*RdRp, NP*, and *MP*	Pigeonpea	Reduced plant susceptibility	[172]

SIGS	Dimeric and inverted repeat transgene	*Potato spindle tuber viroid* *Citrus exocortis viroid* *Chrysanthemum chlorotic mottle viroid*	Viroid genome	Tomato, *Nicotiana benthamiana*, and chrysanths	Reduced plant susceptibility	[173]
SIGS	dsRNA	*Potato Virus Y*	*NIb*	Tobacco	Reduced plant susceptibility	[174]
SIGS	dsRNA delivery from *E. coli* extract	*Tobacco mosaic virus* *Potato virus Y*	Multiple target regions	Tobacco	Reduced plant susceptibility	[175]
SIGS	dsRNA	*Papaya ringspot virus*	*CP*	Papaya	Reduced plant susceptibility	[176]
SIGS	dsRNA delivery from *E. coli* extract	*Cymbidium mosaic virus*	*CP*	Orchid	Reduced plant susceptibility	[177]
SIGS	Naked or *E. coli*-encapsulated dsRNA	*Potato virus X* *Potato virus Y*	*CP*	*Nicotiana benthamiana*	Reduced plant susceptibility	[178]
HIGS	Intron-containing hairpin RNA	*Papaya ringspot virus*	*CP*	Papaya	Reduced plant susceptibility	[179, 180]
HIGS	Intron-containing hairpin RNA	*Soybean mosaic virus*	*eIF4E* gene of plant	Soybean	Reduced plant susceptibility	[181]
HIGS	Intron-containing hairpin RNA	*Soybean mosaic virus*	*GmVma12* gene of plant	Soybean	Reduced plant susceptibility	[182]
HIGS	Inverted repeat transgene	*Alfalfa mosaic virus* *Bean pod mottle virus* *Soybean mosaic virus*	*Rep*	Soybean	Reduced plant susceptibility	[183]
HIGS	Intron-containing hairpin RNA	*Soybean mosaic virus*	*P3*	Soybean	Reduced plant susceptibility	[184]
HIGS	Intron-containing hairpin RNA	*Soybean mosaic virus*	*HC-Pro*	Soybean	Reduced plant susceptibility	[185]
HIGS	Intron-containing hairpin RNA	*Potato leafroll virus*	*MP*	Potato	Reduced plant susceptibility	[186]
SIGS	dsRNA	*Potato virus Y*	*CP*	Potato	Reduced plant susceptibility	[187]

SIGS	dsRNA	*Potato virus Y*	*HC-Pro* and *NIa*	Potato	Reduced plant susceptibility	[188]
HIGS	amiRNA403	*Potato virus Y*	*CP*	Potato	Reduced plant susceptibility	[189]
HIGS	Intron-containing hairpin RNA	*Tomato yellow leaf curl virus*	*CP*, *V2*, and *Rep*	Tomato and *Nicotiana benthamiana*	Reduced plant susceptibility	[190]
HIGS	Intron-containing hairpin RNA	*Pepino mosaic virus*	Multiple target regions	Tomato	Reduced plant susceptibility	[191]
HIGS	Spacer-containing hairpin RNA	*Cucumber mosaic virus*	*Rep*	Tomato	Reduced plant susceptibility	[192]
HIGS	Intron-containing hairpin RNA	*Cucumber mosaic virus*	Multiple target regions	Tomato	Reduced plant susceptibility	[193]
HIGS	Intron-containing hairpin RNA	*Plum pox virus*	5'-UTR/P1 and HC-Pro	Plum and *Nicotiana benthamiana*	Reduced plant susceptibility	[194, 195]
HIGS	Intron-containing hairpin RNA	*Tomato yellow leaf curl Thailand virus*	Multiple target regions	Tomato	Reduced plant susceptibility	[196]
HIGS	Intron-containing hairpin RNA	*Citrus tristeza virus*	Multiple target regions	Citrus	Reduced plant susceptibility	[197]
HIGS	Intron-containing hairpin RNA	*Cotton leaf curl Kokhran virus-Burewala* *Cotton leaf curl Multan betasatellite*	*AC1* *BC1* and *CR*	Cotton	Reduced plant susceptibility	[198]
HIGS	Intron-containing hairpin RNA	*Cotton leaf curl Kokhran virus-Burewala*	*V2*	Cotton	Reduced plant susceptibility	[199]
HIGS	Intron-containing hairpin RNA	*Wheat streak mosaic virus* *Triticum mosaic virus*	*NIb*	Wheat	Reduced plant susceptibility	[200]
HIGS	Spacer-containing hairpin RNA	*Wheat streak mosaic virus*	*TaeIF(iso)4E* and *TaeIF4G* of plant	Wheat	Reduced plant susceptibility	[201]
HIGS	Spacer-containing hairpin RNA	*Wheat streak mosaic virus*	*CP*	Wheat	Reduced plant susceptibility	[202]
HIGS	Intron-containing hairpin RNA	*Wheat yellow mosaic virus*	*TaVTC2* of plant	Wheat	Reduced plant susceptibility	[203]
HIGS	Intron-containing hairpin RNA	*Sorghum mosaic virus*	*CP*	Sugarcane	Reduced plant susceptibility	[204]

HIGS	Intron-containing hairpin RNA	*Sorghum mosaic virus*	*CP*	Sugarcane	Reduced plant susceptibility	[205]
HIGS	amiRNA168	*Sugarcane mosaic virus*	*CP*	Sugarcane	Reduced plant susceptibility	[206]
HIGS	Inverted repeat transgene	*Cassava brown streak Uganda virus*	*CP*	Cassava and *Nicotiana benthamiana*	Reduced plant susceptibility	[207, 208]
HIGS	Sense and antisense expression	*Potato virus Y*	*Protease*	Tobacco	Reduced plant susceptibility	[209]
HIGS	Intron-containing hairpin RNA	*Banana bunchy top virus*	*Rep*	Banana	Reduced plant susceptibility	[210]
HIGS	amiRNA159	*Turnip yellow mosaic virus* *Turnip mosaic virus*	*P69* and *HC-Pro*	Arabidopsis	Reduced plant susceptibility	[211]
HIGS	Intron-containing hairpin RNA	*African cassava mosaic virus*	*AC1*	Cassava	Reduced plant susceptibility	[212]
HIGS	Spacer-containing hairpin RNA	*Sri Lankan cassava mosaic virus*	*AV1* and *AV2*	Cassava	Reduced plant susceptibility	[213]
HIGS	Spacer-containing hairpin RNA	*Potato spindle tuber viroid*	Viroid genome	Tomato	Reduced plant susceptibility	[214]

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Supplementary Table S4. Representative summary of successful studies using *in planta* and topical RNAi to control fungi and oomycetes in plants. HIGS: host-induced gene silencing (transgenesis), SIGS: spray-induced gene silencing (topical), and VIGS: virus-induced gene silencing (viral vectors).

Strategy	RNAi	Fungi	Target gene	Organism	Results	Reference
HIGS	Intron-containing hairpin RNA	*Fusarium oxysporum*	*FoFOW2*, *FoFRP1*, and *FoOPR*	Arabidopsis	Reduced plant susceptibility	[215]
HIGS	Intron-containing hairpin RNA	*Sclerotinia sclerotiorum*	*Ssoah1*	Arabidopsis	Reduced plant susceptibility	[216]
SIGS	Antisense and dsRNA	*Hyaloperonospora arabidopsidis*	*HaCesA3*	Arabidopsis	Reduced plant susceptibility	[217]
HIGS	Inverted repeat transgene	*Fusarium graminearum*	*FgCYP51*	Arabidopsis and barley	Reduced plant susceptibility	[218]
HIGS and SIGS	dsRNA and sense-antisense expression	*Fusarium graminearum*	*FgCYP51A*, *FgCYP51B*, *FgCYP51C*	Arabidopsis and barley	Reduced plant susceptibility	[219]
HIGS	Intron-containing hairpin RNA	*Sclerotinia sclerotiorum*	*Abhydrolase-3*	Arabidopsis and canola	Reduced plant susceptibility	[220, 221]
HIGS and VIGS	Intron-containing hairpin RNA	*Verticillium dahliae*	*VdAve1*, *VdSge1*, and *VdNLP1*	Arabidopsis and tomato	Reduced plant susceptibility	[222]
HIGS	Inverted repeat transgene	*Magnaporthe oryzae*	*RGS1*, *MgAPT2*, and *LHS1*	Arabidopsis and rice	Reduced plant susceptibility	[223]
HIGS	Intron-containing hairpin RNA	*Fusarium oxysporum*	*Velvet* and *FTF1*	Banana	Reduced plant susceptibility	[224]
HIGS	Inverted repeat transgene	*Fusarium oxysporum*	*FocTR4ERG6* and *FocTR4ERG11*	Banana	Reduced plant susceptibility	[225]
HIGS	Intron-containing hairpin RNA	*Blumeria graminis*	Several blumeria effectors	Barley	Reduced plant susceptibility	[226]
SIGS	dsRNA	*Fusarium graminearum*	*CYP51A*, *CYP51B*, and *CYP51C*	Barley	Reduced plant susceptibility	[227]
SIGS	Intron-containing hairpin RNA	*Blumeria graminis*	Various *CSEP* effectors	Barley	Reduced fungal pathogenicity	[228-231]
SIGS	dsRNA	*Fusarium graminearum*	*AGO1*, *AGO2*, *DCL1*, and *DCL2*	Barley	Reduced plant susceptibility	[232]
HIGS	Inverted repeat or antisense	*Blumeria graminis*	*Avra10*	Barley and wheat	Reduced plant susceptibility	[233]
VIGS	Antisense expression	*Puccinia striiformis*	Haustoria-specific	Barley and wheat	Reduced plant susceptibility	[234]
VIGS	Antisense expression	*Puccinia striiformis* and *P. graminis*	Haustoria-specific	Barley and wheat	Reduced plant susceptibility	[235]
SIGS and HIGS in fungi	dsRNA and intron-containing hairpin RNA	Multiple fungus species	*Faß2Tub-3*	Barley, wheat, cucumber, and soybean	Reduced fungal pathogenicity	[236]
HIGS	Inverted repeat transgene	*Verticillium dahliae*	*VdAK*	*Nicotiana benthamiana* and Arabidopsis	Reduced plant susceptibility	[237]
HIGS and VIGS	Antisense and inverted repeat transgene	*Rhizoctonia solani*	*Rstps2*	*Nicotiana benthamiana* and rice	Reduced plant susceptibility	[238]

HIGS	Inverted and spaced repeat transgene	*Fusarium graminearum*	*Fg00677* and *Fg08731*	Brachypodium	Reduced plant susceptibility	[239]
SIGS	dsRNA	*Sclerotinia sclerotiorum* and *Botrytis cinerea*	Multiple genes of pathogen	Canola and arabidopsis	Reduced fungal pathogenicity	[240]
HIGS	Intron-containing hairpin RNA	*Colletotrichum gloeosporioides*	*CgCOM1*	Chilli and tomato	Reduced plant susceptibility	[241]
HIGS	Inverted repeat transgene	*Verticillium dahliae*	*VdH1* gene of pathogen	Cotton	Reduced plant susceptibility	[242]
VIGS	Antisense expression	*Verticillium dahliae*	*VdILV2* and *VdILV6*	Cotton	Reduced plant susceptibility	[243]
VIGS	Antisense expression	*Verticillium dahliae*	*VdRGS1*	Cotton	Reduced plant susceptibility	[244]
SIGS and HIGS	dsRNA and inverted repeat transgene	*Botrytis cinerea* and *Verticillium dahliae*	*DCL1* and *DCL2*	Different fruits and plants	Reduced virulence	[245]
HIGS in fungi	Inverted repeat transgene	*Aspergillus flavus, A. parasiticus, and Fusarium graminearum*	Mycotoxin regulatory	Fungi	Suppressed mycotoxin production	[246]
HIGS in fungi	Sense and antisense expression	*Magnaporthe oryzae*	Calcium signaling-related	Fungi	Reduced fungal pathogenicity	[247]
SIGS	dsRNA	*Botrytis cinerea*	*BcCYP51*, *Bcchs1*, and *BcEF2*	Grapevine	Reduced fungal pathogenicity	[248]
SIGS	dsRNA	*Plasmopara viticola*	*PvDCL1* and *PvDCL2*	Grapevine	Reduced fungal pathogenicity	[249]
SIGS	dsRNA	*Austropuccinia psidii* and *Coleosporium plumeriae*	*B-TUB*, *EF1-a*, and *28S-1*	Jambos	Reduced fungal pathogenicity	[250]
HIGS	Intron-containing hairpin RNA	*Bremia lactucae*	*HAM34* and *CES1*	Lettuce	Reduced plant susceptibility	[251]
SIGS	dsRNA	*Botrytis cinerea*	*Slt2-Type MAP Kinase Bmp3*	Lettuce	Reduced virulence	[252]
HIGS	Intron-containing hairpin RNA	*Aspergillus flavus*	*aflR*	Maize	Reduced aflatoxin accumulation	[253]
HIGS	Intron-containing hairpin RNA	*Aspergillus flavus* and *A. parasiticus*	*aflC*	Maize	Reduced aflatoxin accumulation	[254]
HIGS	Intron-containing hairpin RNA	*Aspergillus flavus*	*aflM*	Maize	Reduced aflatoxin accumulation	[255]
HIGS	Intron-containing hairpin RNA	*Aspergillus flavus*	*Amy1*	Maize	Reduced plant susceptibility	[256]
HIGS	Intron-containing hairpin RNA	*Aspergillus flavus*	*Alk*	Maize	Reduced plant susceptibility	[257]

HIGS	Intron-containing hairpin RNA	*Aspergillus flavus*	*p2c*	Maize	Reduced aflatoxin accumulation	[258]
HIGS	Inverted repeat transgene	*Rhizophagus irregularis*	*RiNLE1*	Medicago	Reduced plant susceptibility	[259]
SIGS	dsRNA	*Podosphaera xanthii*	*CNAP*	Melon	Reduced fungal pathogenicity	[260]
SIGS	dsRNA	Multiple fungus species	*VPS51*, *DCTN1*, *DCL*, and *SAC1*	Multiple plant species	Reduced plant susceptibility	[261]
HIGS	Intron-containing hairpin RNA	*Phytophthora infestans*	*PiGPB1*, *PiCESA2*, and *PiPEC*	Potato	Reduced plant susceptibility	[262]
HIGS	Intron-containing hairpin RNA	*Phytophthora infestans*	*Avr3a*	Potato	Reduced plant susceptibility	[263]
SIGS	dsRNA	*Phytophthora infestans*	*SDH*, *EF-1α*, *GPI-HAM344*, *PLD-3*, and *HSP-90*	Potato	Reduced fungal pathogenicity	[264]
SIGS	dsRNA	*Phytophthora infestans*	*PiGPB1*, *PiHmp1*, *PiCut3*, and *PiEndo3*	Potato	Reduced fungal pathogenicity	[265]
HIGS	Inverted repeat transgene	*Botrytis cinerea*	*DND1* and *DMR6*	Potato and tomato	Reduced plant susceptibility	[266]
HIGS	Inverted repeat transgene	*Botrytis cinerea*	*BcTOR*	Potato and tomato	Reduced plant susceptibility	[267]
HIGS	Inverted repeat transgene	*Magnaporthe oryzae*	*CRZ1*, *PMC1*, *MAGB*, *LHS1*, *CYP51A*, and *CYP51B*	Rice	Reduced plant susceptibility	[268]
HIGS	Inverted repeat transgene	*Rhizoctonia solani*	*RPMK1-1* and *RPMK1-2*	Rice	Reduced plant susceptibility	[269]
HIGS	Inverted repeat transgene	*Ustilaginoidea virens*	*UvChs2* and *UvChs5*	Rice	Reduced plant susceptibility	[270]
HIGS	Intron-containing hairpin RNA	*Ustilaginoidea virens*	*COM1*, *Pro1*, and *AspE*	Rice	Reduced plant susceptibility	[271]
HIGS	Intron-containing hairpin RNA	*Magnaporthe oryzae*	*MoMET2* and *MoCYS2*	Rice	Reduced plant susceptibility	[272]
SIGS	dsRNA	*Magnaporthe oryzae*	*MoDES1*	Rice	Reduced fungal pathogenicity	[273]
SIGS and HIGS	dsRNA and inverted repeat transgene	*Magnaporthe oryzae*	*MoAP1*	Rice	Reduced plant susceptibility	[274]
VIGS	Antisense expression	*Magnaporthe oryzae*	*MoABC1*, *MoMAC1*, and *MoPMK1*	Rice	Reduced plant susceptibility	[275]
HIGS	Intron-containing hairpin RNA	*Fusarium oxysporum*	*CYP51*	Soybean	Reduced plant susceptibility	[276]
HIGS	Intron-containing hairpin RNA	*Fusarium oxysporum*	*SCN-Chs*	Soybean	Reduced plant susceptibility	[125]
SIGS and VIGS	dsRNA and antisense expression	*Phakopsora pachyrhizi*	*ATC*, *RP_S16*, and *GCS_H*	Soybean	Reduced plant susceptibility	[277]

HIGS	Inverted repeat transgene	*Rhizoctonia solani*	*RNApoly*, *Imbs*, *Coh*, and *UbiE3*	Tall fescue	Reduced plant susceptibility	[278]
HIGS	Inverted repeat transgene	*Fusarium verticillioides*	*uidA/GUS*	Tobacco	*uidA/GUS* gene silencing	[279]
HIGS	Intron-containing hairpin RNA	*Sclerotinia sclerotiorum*	*Chitin synthase*	Tobacco	Reduced plant susceptibility	[280]
HIGS	Inverted repeat transgene	*Ciboria shiraiana*	*CsGpa1*	Tobacco	Reduced plant susceptibility	[281]
HIGS and VIGS	Inverted repeat transgene	*Phytophthora parasitica*	*GST* gene of plant	Tobacco	Reduced plant susceptibility	[282]
HIGS	Intron-containing hairpin RNA	*Fusarium oxysporum*	*FOW2* and *chsV*	Tomato	Reduced plant susceptibility	[283]
HIGS	Intron-containing hairpin RNA	*Fusarium oxysporum*	*ODC*	Tomato	Reduced plant susceptibility	[284]
SIGS	dsRNA	*Fusarium oxysporum*	*FolRDR1*	Tomato	Reduced fungal pathogenicity	[285]
SIGS and VIGS	dsRNA and antisense expression	*Rhizoctonia solani*	*RS_CRZ1*	Tomato	Reduced plant susceptibility	[286]
HIGS	RNAi triggered by tissue-specific and constitutive promoters	*Blumeria graminis*	*MLO* genes of plant	Wheat	Reduced plant susceptibility	[287]
HIGS	Antisense expression	*Fusarium culmorum*	*Fgl1*, *Fmk1*, *Gls1*, and *ChsV*	Wheat	Reduced plant susceptibility	[288]
HIGS	Intron-containing hairpin RNA	*Fusarium graminearum*	*Chs3b*	Wheat	Reduced plant susceptibility	[289]
HIGS	Intron-containing hairpin RNA	*Puccinia striiformis*	*PsFUZ7*	Wheat	Reduced plant susceptibility	[290]
HIGS	Intron-containing hairpin RNA	*Puccinia triticina*	*PtMAPK1* and *PtCYC1*	Wheat	Reduced plant susceptibility	[291]
HIGS	Intron-containing hairpin RNA	*Blumeria graminis*	*SvrPm3a1/f1*	Wheat	Reduced plant susceptibility	[292]
HIGS	Intron-containing hairpin RNA	*Puccinia striiformis*	*TaCSN5* gene of plant	Wheat	Reduced plant susceptibility	[293]
HIGS	Intron-containing hairpin RNA	*Fusarium graminearum*	*SGE1*, *PP1*, and *STE12*	Wheat	Reduced plant susceptibility	[294]
HIGS and VIGS	Intron-containing hairpin RNA	*Puccinia striiformis*	*PsCPK1*	Wheat	Reduced plant susceptibility	[295]
SIGS	dsRNA	*Fusarium graminearum*	*Chs7*, *Gls*, and *Pkc*	Wheat	Reduced fungal pathogenicity	[296]
SIGS and HIGS in fungi	dsRNA and intron-containing hairpin RNA	*Fusarium asiaticum*	*Myosin5*	Wheat	Reduced fungal pathogenicity	[297]
SIGS and VIGS	dsRNA and antisense expression	*Fusarium culmorum*	*FcTRI5*	Wheat	Reduced fungal pathogenicity	[298]

VIGS	Sense or antisense expression	*Puccinia triticina*	*MAPK*, *cyclophilin*, and *calcineurin*	Wheat	Reduced plant susceptibility	[299]
VIGS	Antisense expression	*Puccinia striiformis*	*PsCNA1* and *PsCNB1*	Wheat	Reduced plant susceptibility	[300]
VIGS	Antisense expression	*Puccinia striiformis*	*Pst_8713*	Wheat	Reduced plant susceptibility	[301]
VIGS	Antisense expression	*Puccinia striiformis*	*PsKPP4*	Wheat	Reduced plant susceptibility	[302]
VIGS	Antisense expression	*Puccinia striiformis*	*PsANT*	Wheat	Reduced plant susceptibility	[303]
VIGS	Antisense expression	*Puccinia striiformis*	*PsSRPKL*	Wheat	Reduced plant susceptibility	[304]
VIGS	Antisense expression	*Puccinia striiformis*	*PsRan*	Wheat	Reduced fungal growth	[305]
VIGS	Antisense expression	*Puccinia graminis*	*Pgt-IaaM*	Wheat	Reduced plant susceptibility	[306]
VIGS	Antisense expression	*Puccinia striiformis*	*PsSOD1*	Wheat	Reduced plant susceptibility	[44]
VIGS	Antisense expression	*Puccinia striiformis*	*PstMCM1-1*	Wheat	Reduced plant susceptibility	[307]
VIGS and HIGS	Antisense and inverted repeat transgene	*Puccinia striiformis*	*Pst_4* and *Pst_5*	Wheat	Reduced plant susceptibility	[308]
VIGS and HIGS	Intron-containing hairpin RNA	*Puccinia striiformis*	*PstGSRE1*	Wheat	Reduced plant susceptibility	[309]
SIGS	dsRNA	*Fusarium graminearum*	Multiple genes of the pathogen	Wheat and barley	Reduced fungal pathogenicity	[310]
SIGS	dsRNA	*Fusarium crown*	*FoCYP51*, *FoChs1*, and *FoEF2*	Tomato	Reduced fungal pathogenicity	[311]

Supplementary Table S5. Summary of studies using nanoformulations for delivering dsRNA/siRNA through spray/topical application in insect pests.

Target organism			Target gene	Nanoformulation details			Efficacy		Particle characteristics		References
Order	**Species**	**Host**		**RNAi molecule size (bp)**	**Nanoparticle**	**Delivery method**	**Knockdown (%)**	**Mortality (%)**	**Size (nm)/ Charge (mV)**	**Shape**	
Lepidoptera	*Helicoverpa armigera*	Cotton	*Chitinase, lipase*	siRNA	Chitosan/TPP	Sprayed leaves	100	90	100/36	Spherical	[312]
Hemiptera	*Sogatella furcifera*	Rice	*Tyrosine hydroxylase*	Uninformed	Star polycation/detergent	Sprayed seedlings	80	44	Uninformed	Uninformed	[313]
Hemiptera	*Myzus persicae*	Rapeseed	*V-type proton ATPase subunits D and G*	330-508	Star polycation/detergent	Sprayed leaves	50	60	Uninformed	Uninformed	[314]
Thysanoptera	*Frankliniella occidentalis*	Hot peppers	*vATPase*	Uninformed	Liposome	Sprayed plants	NP	56	Uninformed	Uninformed	[315]
Hemiptera	*Aphis gossypii*	Cotton	*CYP6CY13*	388	Rough-surface hollow mesoporous silica	Sprayed leaves	40	80	153/33	Mesoporous	[316]
Hemiptera	*Sogatella furcifera*	Rice	*Antp, EGF, zfh-2*	Uninformed	Star polycation/detergent	Direct spray on nymphs	80	40	Uninformed	Uninformed	[317]
Hemiptera	*Nilaparvata lugens*	Rice	*Chitin synthase*	440	Polyethylene glycol/chitosan	Direct spray on nymphs	54	40	100-200/26	Spherical	[318]
Hemiptera	*Bemisia tabaci*	Cotton	*Syntaxin binding protein-1,2,3*	255	MgFe-layered double hydroxide	Sprayed leaves	90	90	2000-5000	Bundle-like	[319]
Hemiptera	*Eriosoma lanigerum*	Apple tree	*V-ATPase subunit D*	Uninformed	Cationic dendrimer/detergent	Transdermal	98	55	Uninformed	Uninformed	[320]
Hemiptera	*Myzus persicae*	Radish	*Vestigial, Ultrabithorax*	489 and 359	Star polycation/detergent	Transdermal	44	60	Uninformed	Uninformed	[321]

Lepidoptera	*Grapholita molesta*	Fruit trees	*Neuropeptide F*	220	Star polycation/detergent	Transdermal and direct spray	60	66	Uninformed	Uninformed	[322]
Orthoptera	*Locusta Migratoria*	Wheat	*Chitin synthase B*	Uninformed	Poly(ethylene glycol)-polylysine(thiol)	Sprayed leaves	60	10	55/21	Core-shell	[323]
Lepidoptera	*Helicoverpa armigera*	Chickpea	*JH methyl transferase and acetylcholine esterase*	siRNA	Chitosan	Sprayed leaves	100	99	100/32	Spherical	[324]
Lepidoptera	*Chilo suppressalis*	Rice	*CYP15C1*	352	Star polycation/detergent	Sprayed seedlings	50	60	Uninformed	Uninformed	[325]
Lepidoptera	*Spodoptera frugiperda*	Corn, Rice	*Inhibitor of apoptosis*	350	Chitosan	Sprayed diet	40	47	200/25	Spherical	[326]
Hemiptera	*Aphis glycines*	Soybean	*Trehalase, vATPase D* and *E*, and *chitin synthase 1*	430-530	Star polycation/detergent	Transdermal and direct spray	86	80	Uninformed	Uninformed	[65]
Hemiptera	*Aphis glycines*	Soybean	*Hemocytin*	555	Functionalized perylene diimides	Transdermal	95	80	Uninformed	Uninformed	[327]
Lepidoptera	*Spodoptera exigua*	Chinese cabbage	*Chitin synthase B*	Uninformed	Guanidine-containing polymers	Sprayed leaves	53	50	350/30	Spherical	[328]
Hemiptera	*Acyrthosiphon pisum*	Legumes	*Carotene dehydrogenase and BCAAT*	siRNA	Perfluorocarbon	Sprayed aphid mass	30	0	Uninformed	Uninformed	[329]

CYP: cytochrome p450 protein. *JH*: juvenile hormone. *Antp*: Antennapedia. *EGF*: epidermal growth factor. *Zfh-2*: zinc finger homeodomain-2. *BCAAT*: branched chain-amino acid transaminase.

Supplementary Table S6. Key steps from validating a RNAi strategy to product commercialization focused on drawbacks and advances to control insect pests, plant-parasitic nematodes, virus and subviral agents, fungi, and oomycetes. HIGS: host-induced gene silencing (transgenesis), SIGS: spray-induced gene silencing (topical), and VIGS: virus-induced gene silencing (viral vectors).

Target organism	RNAi strategy	Goal	Specific use	Drawbacks	Advantages
Insect pests	dsRNA injection	Proof-of-concept	Validation of target genes and dsRNA delivery	Delivery is not used on a large scale	Fast and low-cost method for laboratory scale
	dsRNA ingestion	Proof-of-concept	Validation of target genes and dsRNA delivery	Delivery is not used on a large scale	Fast and low-cost method for laboratory scale
	Transient delivery of transgene and dsRNA production in plants	Proof-of-concept	Validation of target genes and dsRNA delivery	Delivery is not used on a large scale	Fast and low-cost method for laboratory scale
	dsRNA uptake by plant cuttings or roots	Proof-of-concept	Validation of target genes and dsRNA delivery	Delivery is not used on a large scale and depends on the target plant or insect pest species	Fast and low-cost method for laboratory scale, but still requires considerable advances for commercial use in the open field
	HIGS by stable transgene insertion in transgenic plants	Commercial product	Large-scale control of insect pests	Transgenic, high cost for biosafety regulation, and eventual transgenerational instability	Stable technology transferred through propagative material and high delivery efficacy
	SIGS by topical delivery of dsRNA in plants or insect pests	Commercial product	Large-scale control of insect pests	Recurrent applications and challenges with dsRNA delivery, stability, uptake, cross-talk, and durability	Non-transgenic, greater public acceptance, lower cost for biosafety regulation, and the possibility of down-regulate multiple targets
Plant-parasitic nematodes	Soaking by placing nematodes in a solution containing dsRNA	Proof-of-concept	Target genes validation	Delivery is not used on a large scale	Fast and low-cost method for laboratory scale
	Composite plants (hairy root culture)	Proof-of-concept	Validation of target genes and dsRNA delivery	Delivery is not used on a large scale	Fast and low-cost method for laboratory scale
	HIGS by stable transgene insertion in transgenic plants	Commercial product	Large-scale control of nematodes	Transgenic, high cost for biosafety regulation, and eventual transgenerational instability	Stable technology transferred through propagative material and high delivery efficacy

	SIGS by topical delivery of dsRNA in plants or nematodes	Commercial product	Large-scale control of nematodes	Recurrent applications and challenges with dsRNA delivery, stability, uptake, cross-talk, and durability	Non-transgenic, greater public acceptance, lower cost for biosafety regulation, possibility of down-regulate multiple targets, and potential use in seed treatment
Viruses and subviral agents	VIGS by virus-induced silencing	Proof-of-concept	Validation of target genes and dsRNA delivery	Delivery is not used on a large scale	Fast and low-cost method for laboratory scale
	Transient delivery of transgene and dsRNA production in plants	Proof-of-concept	Validation of target genes and dsRNA delivery	Delivery is not used on a large scale and depends on the target plant or virus species	Fast and low-cost method for laboratory scale
	HIGS by stable transgene insertion in transgenic plants	Commercial product	Large-scale control of viruses	Transgenic, high cost for biosafety regulation, and eventual transgenerational instability	Stable technology transferred through propagative material and high delivery efficacy
	SIGS by topical delivery of dsRNA in plants	Commercial product	Large-scale control of viruses	Recurrent applications and challenges with dsRNA delivery, stability, uptake, cross-talk, and durability	Non-transgenic, greater public acceptance, lower cost for biosafety regulation, and possibility of down-regulate multiple targets
Fungi and oomycetes	VIGS by virus-induced silencing	Proof-of-concept	Validation of target genes and dsRNA delivery	Delivery is not used on a large scale	Fast and low-cost method for laboratory scale
	Transient delivery of transgene and dsRNA production in plants	Proof-of-concept	Validation of target genes and dsRNA delivery	Delivery is not used on a large scale	Fast and low-cost method for laboratory scale
	dsRNA uptake by plant cuttings or roots	Proof-of-concept	Validation of target genes and dsRNA delivery	Delivery is not used on a large scale and depends on the target plant or pathogen species	Fast and low-cost method for laboratory scale, but still requires considerable advances for commercial use in the open field
	HIGS by stable transgene insertion in transgenic plants	Commercial product	Large-scale control of plant pathogens	Transgenic, high cost for biosafety regulation, and eventual transgenerational instability	Stable technology transferred through propagative material and high delivery efficacy

	SIGS by topical delivery of dsRNA in plants	Commercial product	Large-scale control of plant pathogens	Recurrent applications and challenges with dsRNA delivery, stability, uptake, cross-talk, and durability	Non-transgenic, greater public acceptance, lower cost for biosafety regulation, and possibility of down-regulate multiple targets
Model plant or crops	VIGS by virus-induced silencing	Proof-of-concept	Validation of target genes and dsRNA delivery	Delivery is not used on a large scale	Fast and low-cost method for laboratory scale
	Transient delivery of transgene and dsRNA production in plants	Proof-of-concept	Validation of target genes and dsRNA delivery	Delivery is not used on a large scale	Fast and low-cost method for laboratory scale
	Composite plants (hairy root culture)	Proof-of-concept	Validation of target genes and dsRNA delivery	Delivery is not used on a large scale	Fast and low-cost method for laboratory scale
	HIGS by stable transgene insertion in transgenic plants	Commercial product	Large-scale improvements of traits	Transgenic, high cost for biosafety regulation, and eventual transgenerational instability	Stable technology transferred through propagative material, high delivery efficacy, and highly effective for down-regulation of endogenous genes
	SIGS by topical delivery of dsRNA in plants	Commercial product	Large-scale improvements of traits	Recurrent applications and challenges with dsRNA delivery, stability, uptake, cross-talk, and durability	Non-transgenic, greater public acceptance, lower cost for biosafety regulation, possibility of down-regulate multiple targets, use in plant priming for better agronomic performance, and use in seed treatment

Supplementary Table S7. Examples of companies and startups focused on *in planta* and topical RNAi-based technologies for agriculture.

Company name	Company origin	Scope	RNAi-based commercial products	Major target-specie
Bayer Crop Science	Germany	Transgenic plants to control pests	SmartStax PRO® VT4PRO™	*Diabrotica virgifera virgifera* (Coleoptera)
Syngenta	Switzerland	Transgenic plants to control pests	In development	N.A
Corteva	USA	Transgenic plants to control pests	Vorceed Enlistt® Corn	*Diabrotica virgifera virgifera* (Coleoptera)
FuturaGene	Israel	Transgenic plants to control pests	In development	*Eucalyptus sp.* (Myrtales)
PlantArcBio - ICL Planet	Israel	Improvement of crop yields and biostimulants	In development	*Brassica napus* (Brassicales)
Greenlight Bioscience	USA	Cell-free bioproduction of dsRNA to control pests and RNAi-based products	Calantha™	*Leptinotarsa decemlineata* (Coleoptera)
AgroRNA	Korea	*In vitro* transcription platform for dsRNA synthesis	N.A	N.A
AgroSpheres	USA	Platform for manufacturing, encapsulation, and dsRNA delivery	N.A	N.A
Sempre AgTech	Brazil	Topical application of dsRNA to control pests	In development	N.A
The University of Queensland in partnership with Nufarm	Australia	Nanoformulation for dsRNA delivery	BioClay™	N.A
Renaissance BioScience	Canada	Yeast-based RNAi platform	In development	*Leptinotarsa decemlineata* (Coleoptera)
Agrivalle Brasil	Brazil	Large-scale bioproduction of dsRNA and topical RNAi application to control pests	In development	N.A
RNAiSSANCE Ag	USA	Development of sprayable RNAi-based products	In development	*Plutella xylostella* (Lepidoptera)
NanoSUR	USA	Topical application of dsRNA to control pests	In development	N.A
Trillium Ag	USA	Formulation for topical dsRNA delivery	Agrisome	N.A
Pebble Labs	USA	Engineering of naturally occurring microbes to deliver dsRNA	N.A	N.A
Innatrix	USA	Combination of peptides to block disease-promoting proteins, and dsRNA	InnaNema™	*Heterodera glycines* (Tylenchida)

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